TRANSPORT AND PHASE EQUILIBRIA PROPERTIES FOR STEAM FLOODING OF HEAVY OILS

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Grant: DE-FG26-98FT40147
Period: 05/31/00 - 06/01/01

ABSTRACT

Hydrocarbon/water and CO_2 systems are frequently found in petroleum recovery processes, petroleum refining, and gasification of coals, lignites and tar sands. Techniques to estimate the phase volume and phase composition are indispensable to design and improve oil recovery processes such as steam, hot water, or CO_2/steam combinations of flooding techniques typically used for heavy oils.

An interdisciplinary research program to quantify transport, PVT, and equilibrium properties of selected oil/ CO_2/water mixtures at pressures up to 10,000 psia and at temperatures up to 500 ^oF has been put in place.

The objectives of this research include experimental determination and rigorous modeling and computation of phase equilibrium diagrams, volumetric, and transport properties of hydrocarbon/CO_2/water mixtures at pressures and temperatures typical of steam injection processes for thermal recovery of heavy oils.

The project is divided in an experimental and a theoretical part. For the experimental part, we have measured bubble points and pressure-volume relations for four different oil samples. For the theoretical part a computer program to implement the technique to calculate phase equilibrium diagrams known as the area method was developed. This method though correct to predict binary mixtures equilibrium data has proved too cumbersome for multi-component calculations. A new method to compute multi-component phase equilibrium diagrams based on an improved version of the Peng-Robinson equation has been developed. This new version of the Peng-Robinson equation

uses a new volume translation scheme and new mixing rules to improve the accuracy of the calculations. Calculations involving binary and ternary mixtures of CO_2/water and hydrocarbons are reported. A scheme to characterize multi-component materials such as, oils into a small set of "pseudo-components" has been implemented. The final goal is to be able to duplicate the predicted phase behavior diagrams for mixtures of CO_2/water and real oils at high pressures and temperatures.

Publications:

The paper "New Mixing Rules and Volume Correction Scheme for Phase Equilibria Calculations of Complex Hydrocarbon Mixtures." By K. Shukla and J. Gabitto has been submitted for publication to the Journal of Fluid Phase.

The paper "New Mixing Rules and Volume Correction Scheme for Calculations of Complex Hydrocarbon Mixtures Phase Equilibrium." By K. Shukla and J. Gabitto has been published in the Proceedings of the AIChE Annual Meeting, Los Angeles, November 2000.

The same paper was presented in the aforementioned meeting.

Graduate and Undergraduate Students Involved in the Project:

Mr. Marcelo Rame worked on his Master Thesis funded from this project. Mr. Rame developed several computer subroutines to be used in the numerical calculation of phase equilibria by the Peng-Robinson method.

Ms. Kattina Carr, a Prairie View A&M University graduate student has been working on the project since January 2000.